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ADDITION

TO THE

MEMOIR ON THE SOLAR ECLIPSE OF JUNE 16, 1806,

By NATHANIEL BOWDITCH, A.M. et A.A.S.

SINCE the communication of my observations of the solar eclipse of June 16, 1806, I have endeavored to procure the observations made in New-England on the northern and southern limits of the total darkness in order to deduce from them the true latitude of the moon at the time of the ecliptic conjunction of the Sun and Moon. The only observations I have yet been able to obtain are those made at Pawlet in Vermont, on the northern limit of the shadow, and at Tarpaulin-Cove, Nashewena, Martha's Vineyard, and Falmouth on the southern limit.

The observations at Pawlet were made by Captain Potter and published a few days after by Doctor Williams. At the time of the greatest obscuration Captain Potter observed "that the light of the Sun "instantly ceased for a moment or second of time, and as instantaneously appeared." The place where this observation was made is about 40 rods south of the northern boundary of Pawlet, in the latitude of about 43° 24′ N, (or 43° 12′ 33″ reduced to the centre) and in the longitude of from 50″ to 66″ in time west of the place in Rutland, where Doctor Williams observed the eclipse; this place by his observations is in the longitude of 4h. 51′ 53″ W from Greenwich, as will be shown in the course of this memoir, therefore Pawlet is nearly in the longitude of 4h. 52′ 51″ W from Greenwich. With this latitude and longitude and making use of the elements in the former part of this memoir as found in the tables of the third edition of La Lande's

Astronomy, supposing the error of the lunar tables to be in longitude —25″·5, and in latitude —6″·8,* I found the *mean* time of the least apparent distance of the centres of the sun and moon at Pawlet was at 11h. 14′ 4″ The ☽'s parallax —☉'s parallax, in longitude was then +7′ 53″·86, in latitude —21′ 4″·72; the moon's apparent semidiameter 16′ 41″·18; the sun's semidiameter 15′ 42″·5, being the same during the whole of the eclipse. In estimating the semidiameters I supposed the irradiation to decrease the sun's semidiameter 3½″, and the inflexion to decrease the moon's semidiameter 2″; these being the numbers made use of by La Lande in his Tables. The error that might arise in calculating the moon's latitude at the ecliptic conjunction, from an error in the estimated values of the semidiameters of the sun and moon, will in general be obviated by taking the mean of an equal number of observations on the northern and southern limits of the total darkness; and the error that might arise in the calculated time of the ecliptic conjunction will be nearly obviated, by taking the mean of the times deduced from the beginning and end of the eclipse, or from the beginning and end of the total darkness. From the preceding data I found that the least distance of the centres of the sun and moon according to the tables thus corrected was 58″·28, and the difference of their semidiameters 58″·68. The difference of these numbers 0″·4, is nearly the additional correction to be applied to the latitude, making the whole correction —7″·2. This is the only northern observation I could procure.

In a communication made to me by Mr. D. Leslie of New-Bedford, he remarks that the Eclipse was observed to be total at Tarpaulin-Cove, "the duration being at least one minute," and at the northeast part of the Island of Nashewena five miles W S W from Tarpaulin-Cove, "the Eclipse was not total but the lucid part was very "small and of a circular form and appeared very much agitated; "suddenly changing its place round the south limb of the moon." By comparing the latitudes and longitudes of these places as given by Mr. Leslie with those marked on two well executed and apparently accurate charts of the Elizabeth Islands &c. surveyed by Hollond, it appears that the latitude of Tarpaulin-Cove is 41° 28′ 25″ N, which, reduced to the centre, is 41° 17′ 2″, and the longitude 4h. 42′ 59″ W from Greenwich; and that the NE part of Nashewena is in the latitude of 41° 26′ 43″ N (reduced 41° 15′ 20″), and the longitude 4h. 43′ 22″ W from Greenwich. Hence I found by a calculation similar to that made with the Pawlet observation, that the *mean* time of the least apparent distance of the centres of the sun and moon at Tarpaulin-Cove was 11h. 28′ 32″. The ☽'s parallax—☉'s parallax, in longitude +5′ 26″·93, in latitude—18′ 51″. 75, and the moon's apparent semidiameter 16′ 41″·52. The apparent motion of the moon from the sun in half a minute of time 11″·58. The apparent difference of the semidiameters of the sun and moon 59″·02. Hence, if the duration of the total darkness at Tarpaulin-Cove be supposed exactly one minute, the least distance of the centres resulting would be $\left|\overline{\overline{59{\cdot}02}|^{2}-\overline{11{\cdot}58}|^{2}}\right|^{\frac{1}{2}}=57''{\cdot}87$. The distance at that time by the tables corrected as before (in the longitude of the moon —25″·5 and in the latitude —6″·8) was 59″·58. The difference between this and 57″·87 is 1″·7, which is nearly the additional correction to be applied to the latitude of the moon; making the whole correction —8″·5. This result would be but little affected by a few seconds error in the duration of total darkness. For if we suppose the eclipse to have been just total, the least distance, instead of being 57″·87, would be 59″·02, and the correction of the latitude would be varied by the difference of the two numbers ; that is, by 1″·15. So that this error of 60″ in the duration would only cause an error of 1″·15 in the latitude. By a similar calculation the *mean* time of the least apparent distance of the centres of the sun and moon at Nashewena was 11h. 27′ 57. The ☽'s parallax—⊙'s parallax, in longitude +5′ 34″·01, in latitude—18′ 50″·68, the moon's apparent semidiameter 16′ 41″·51. Hence the least apparent distance of the centres of the sun and moon by the tables corrected as above was 61″·34, the apparent difference of the semidiameters was 59″·01 ; the difference, 2″·3, being added to 6″·8, gives nearly the limit of the correction of latitude —9″·1. That is, the correction to be subtracted from the latitude given by the tables must be less than 9″·1, because the eclipse did not appear to be total. This observation confirms in a degree the result obtained from the observation at Tarpaulin-Cove; namely,—8″·5.

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* These numbers were obtained by a first approximation, and they will be found to agree nearly with the true values given in this memoir.

Mr. Leslie also informed me that the eclipse was observed at Martha's Vineyard by several persons on the point called West-Chop, about half a mile from the extremity of the point, at which place the total darkness continued about a minute; and at the distance of a mile and a quarter south of this place the eclipse was not total. By the above charts the latitude of the former point is 41° 28′ 10″ N (reduced 41° 16′ 47″); the latter 41° 26′ 55″ N (reduced 41° 15′ 32″); and the longitude 4h. 42m. 16s. W from Greenwich. From these data I found, by calculations similar to the foregoing, that the mean time of the least apparent distance of the sun and moon was at 11h. 29m. 37s; and at the first place the ☽'s parallax—⊙'s parallax in longitude was +5′ 14″·32, in latitude —18′ 50″.31; the moon's apparent semidiameter 16′ 41″·54, the apparent motion of the moon from the sun in half a minute of time 11″·58, and the apparent difference of the semidiameters of the sun and moon 59″·04. Hence, if the duration of total darkness was one minute, the least distance of the centres of the sun and moon would be $\sqrt{\overline{59\cdot04}|^2-\overline{11\cdot58}|^2}=57''\cdot89$. The distance at that time by the tables, corrected in longitude and latitude as in the above calculations, was 59″·79. The difference between this and 57″·89 is 1″·9, which is nearly the additional correction to be applied to the latitude of the moon, making the whole correction —8″·7. At the southern place of observation the ☽'s parallax—☉'s parallax in longitude was +5′ 14″·49, in latitude —18′ 49″·10, and the moon's apparent semidiameter 16′ 41″·54. Hence the least apparent distance of the centres of the sun and moon, by the tables, corrected as above, was 61″·0. The apparent difference of their semidiameters was 59″·04. The difference of these numbers, 1″·96, being added to 6″·8 gives nearly the limit of the error of the tabular latitude —8″·76 ; that is, the correction to be subtracted from the latitude given by the tables must be less than 8″·76, because the eclipse was not total. This agrees with the northern observation just calculated, which made the correction —8″·7. This quantity will be taken for the tabular correction deduced from the observations at the Vineyard.

From the observations made at Falmouth and communicated to President Webber by Mr. Elisha Clap, it appears that the south limit of the shadow at Wood's Hole was at the sea shore in the latitude of 41° 33′, or 41° 33′ 30″. By comparing the situation of this place on Mr. Clap's chart with the abovementioned charts of the Elizabeth Islands, I am induced to believe that the latitude of this point is 41° 33′ N (reduced 41° 21′ 37″), and the longitude 4h. 42′ 20″ W from Greenwich. Hence I find that the *mean* time of the least apparent distance of the sun and moon was 11h. 29′ 32″. The ☽'s parallax—☉'s parallax, in longitude +5′ 14″·80, in latitude —18′ 55″·30, and the moon's apparent semidiameter 16′ 41″·52. From which it follows that the correction of the moon's latitude is by this observation —2″·7. The mean of this and of the results obtained from the observations at Tarpaulin-Cove and Martha's Vineyard is —6″·6, which may be assumed as the error in latitude deduced from the observations at the southern limit of the shadow.

The eclipse was not total at Nantucket in the latitude of 41° 15′ 32″ N and in the longitude of 4h. 40′ 0″ W from Greenwich, as was observed by Mr. Walter Folger jun. The only deduction I have made from this observation is, that the error in the tabular latitude was less than 20″.

By taking the mean of the error in latitude determined at the northern limit, namely —7″·2, and that at the southern limit —6″·6, we have the error of the tables in latitude as determined by the mean of all the observations —6″·9. The quantity thus determined is (as was before observed) independent of any error in the estimated values of the semidiameters of the sun and moon. Now in the former part of this memoir it was shown that at 11h. 30′ 14″ mean time at Salem, the moon's latitude by the tables was 19′ 50″·3 N, and the horary decrease of latitude corresponding to the middle time between 11h. 30′ 14″ and the conjunction, 11h. 37′ 20″·7, was 3′ 23″·63. Hence at the time of the conjunction the latitude by the tables was 19′ 26″·2, and as the correction obtained above was —6″·9, the true latitude at the time of the ecliptic conjunction was by these observations 19′ 19″·3. This latitude will be made use of in the rest of this memoir, in calculating several observations made in this country.

OBSERVATIONS AT SALEM.

FROM the calculations before made on the observations at Salem

	Mean time.		
we may easily deduce from the observed beginning and end of the eclipse, that the ecliptic conjunction was at - - - - - - -	11h.	37′	19″·2
And by the beginning and end of total darkness	11	37	22·1
The mean time of the four observations gives the ecliptic conjunction at Salem - -	11	37	20·7

In making the preceding calculations it was supposed that Salem was in the longitude of 4h. 43′ 32″ W from Greenwich. Hence it would follow that the ecliptic conjunction at Greenwich was at 4h. 20′ 52″.7 mean time, or 4h. 20″ 45″·9 apparent time; and as Paris is 9′ 18″·8 east of Greenwich, the ecliptic conjunction at Paris would be at 4h. 30′ 11″·5 mean time, or 4h. 30′ 4″·7 apparent time. These times may be liable to an error of 4″ or 5″ from the uncertainty in the longitude of Cambridge, from which that of Salem is deduced.

It was found in the former part of these calculations that at 11h. 30′ 14″ *mean* time at Salem, the longitude of the sun, as given by the tables in the third edition of La Lande's astronomy, was 2s. 24° 44′ 22″·4, the longitude of the moon 2s. 24° 40′ 43″·8,* the sun's horary motion 2′ 23″·15, the moon's horary motion in longitude, corresponding to the middle time between 11h. 30′ 14″ and the ecliptic conjunction, 36′ 41″·97. Hence at the conjunction the tabular longitude of the sun was 2s. 24° 44′ 39″·4, and that of the moon 2s. 24° 45′ 4″·8; so that, if the solar tables were correct, the moon's tabular longitude was too great by 25″·4. If we suppose an error of l seconds of time in the longitude of Salem, making the true longitude equal to 4h. 52′ 51″+l west from Paris, the error of the moon's longitude will be —25″·4—0″·57·l.

OBSERVATIONS AT RUTLAND.

THE observations at Rutland were made by Dr. Samuel Williams, who observed the beginning of the eclipse at 9h. 55′ 12″ apparent time, and the end at 12h. 37′ 51″† apparent time. The eclipse was not total,

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* In calculating this longitude allowance was made for the error 0″·7, mentioned in the first page of the explanation of those tables.

† In some of the public papers this was printed by mistake 12h. 32′ 51″. I wrote to Doctor Williams on this subject, and he informed me that in the Rutland Gazette of June 21, 1806, where he published the observations, the time was very distinctly printed 12h. 37′ 51″.

" but at 11h. 11′ 47″ apparent time the sun's limb appeared to be re-
" duced to a small circular thread, or rather like a very fine horn, the
" upper end of which broke into a drop and instantly disappeared.
" The lucid part of the sun evidently decreased till 11h. 16′ 52″. The
" position of the lucid part at that time seemed to change suddenly to
" the east, and in a few minutes appeared on that part of the sun, where
" the eclipse began, and the light instantly increased before there was
" any appearance to the eye of an increase of the lucid part." The latitude of the place of observation was 43° 36′ N (reduced 43° 24′ 32″ N). The longitude made use of in calculating the parallaxes was 4h. 52′ 32″ W from Greenwich. The moon's parallax *minus* the sun's parallax at the beginning of the eclipse was, in longitude +21′ 10″·2, in latitude —23′ 57″·2; and at the end of the eclipse was in longitude —7′ 27″·2, and in latitude —20′ 36″·4. The moon's semidiameter at the beginning was 16′ 39″·3, at the end 16′ 41″·7. Hence the mean time of the ecliptic conjunction at Rutland was 11h. 28′ 59″·7. This, subtracted from the mean time of the conjunction at Salem, 11h. 37′ 20″·7, leaves the longitude of Rutland 8′ 21″ W from Salem, or 4h. 51′ 53″ W from Greenwich.

It appears by calculation that the least apparent distance of the centres of the sun and moon at Rutland was at 11h. 15′ 36″ mean time, and that the eclipse would have been total if the error of the tables of the moon's latitude at the time of the conjunction had been +4″·5, instead —6″·9, found by the other observations.

The observations made at Albany, Kinderhook, Philadelphia, Lancaster, and Natches, were communicated by Mr. Ferrer to President Webber, who politely furnished me with a copy, from which I have deduced the longitudes of those places, as in the following calculations.

OBSERVATIONS AT ALBANY BY MR. S. DE WITT.

LATITUDE of place 42° 38′ 39″ N, reduced 42° 27′ 13″ N. Longitude made use of in calculating the parallaxes 4h. 55′ 4″·7 W from Greenwich.

	Mean time.	☽'s semidia.	☽'s par.—⊙'s par. in long.	in lat.
	h ′ ″	′ ″	′ ″	′ ″
Beginning of total darkness	11· 8·12·6	16·41·2	+9· 7.3	—20·28·1
End of total darkness	11·13· 3·6	16·41·2	+8·14·5	—20·21·3

Hence the mean time of the ecliptic conjunction was	11h.	25′	51″·	1
This, subtracted from the time of the conjunction at Salem,	11	37	20	7
Leaves the longitude of Albany W from Salem		11	29	6
. . . . or W from Greenwich	4	55	1	6

OBSERVATIONS AT KINDERHOOK, NEW YORK.

LATITUDE of Kinderhook 42° 23′ 3″ N, reduced 42° 11′ 37″ N. Longitude made use of in calculating the parallaxes 4h. 55′ 13″ W from Greenwich.

	Mean time.	☽'s S. D.	☽'s par.—⊙'s par. in long.	in lat.
	h. ′ ″	′ ″	′ ″	′ ″
Beginning of the eclipse	9·49·37	16·39·2	+22·34·9	—23· 4·6
Beginning of total darkness	11· 8· 2	16·41·2	+ 9·12·5	—20·12·9
End of total darkness	11·12·39	16·41·2	+ 8·22·0	—20· 6·4
End of the eclipse	0·33·45	16·41·8	— 6·44·6	—19·22·1

	Mean time.			
Hence the ecliptic conjunction by the external contacts was at	11h.	25′	42″·	0
. . . . internal contacts	11	25	42	3
The mean of all four observations gives the eclipt. conj. at	11	25	42	1
This, subtracted from the time of the conjunction at Salem,	11	37	20	7
Leaves the longitude of Kinderhook W from Salem		11	38	6
. . . . or W from Greenwich	4	55	10	6

OBSERVATIONS AT PHILADELPHIA, BY MR. PATTERSON.

LATITUDE of Philadelphia 39° 57′ 2″ N, reduced 39° 45′ 44″ N. Longitude made use of in calculating the parallaxes 5h. 0′ 37″ W from Greenwich.

	Mean time.	☽'s S. D.	☽'s par.—☉'s par.	
			in long.	in lat.
	h. ′ ″	′ ″	′ ″	′ ″
Beginning of the eclipse	9·40· 5	16·39·1	+25· 9·6	—21·15·2
End of the eclipse	0·26·14	16·42·1	— 5·22·7	—16·52·8

	Mean time.			
Hence the ecliptic conjunction was at . . .	11h.	20′	17″	.0
This, subtracted from the time of the conj. at Salem,	11	37	20	7
Leaves the longitude of Philadelphia W from Salem .		17	3	7
. . . . or W from Greenwich	5	0	35	7

OBSERVATIONS AT LANCASTER, PENNSYLVANIA, BY MR. A. ELLICOTT.

LATITUDE of Lancaster 40° 2′ 36″ N, reduced 39° 51′ 18″ N. Longitude made use of in calculating the parallaxes 5h. 5′ 23″ W from Greenwich.

	Mean time.	☽'s. S. D.	☽'s par.—☉'s par.	
			in long.	in lat.
	h ′ ″	′ ″	′ ″	′ ″
Beginning of the Eclipse.	9·53·14	16·38·9	+26·13·7	—21·42·6
End of the Eclipse.	0·19· 2	16·42·1	— 3·55·8	—16·58·4

	Mean time.			
Hence the ecliptic conjunction was at	11h.	15′	29″	·2
This subtracted from the time of the conjunction at Salem	11	37	20	7
Gives the longitude of Lancaster W from Salem		21	51	5
. . . . or W from Greenwich	5	5	23	5

OBSERVATIONS AT NATCHES, BY MR. W. DUNBAR.

LATITUDE of Natches 31° 27′ 48″ N, reduced 31° 17′ 36″ N. Longitude made use of in calculating the parallaxes 6h. 5′ 31″ W from Greenwich.

	Mean time.	☽'s S. D.	☽'s par.—☉'s par.	
			in long.	in lat.
	h ′ ″	′ ″	′ ″	′ ″
Beginning of the Eclipse	8· 5·24	16·35·1	+42·43·4	—19·44·0
End of the Eclipse	10·38·55	16·41·6	+17·56·5	—10. 7·7

	Mean time.			
Hence the ecliptic conjunction was at	10h.	15′	20″	·4
This subtracted from the time of conjunction at Salem	11	37	20	7
Gives the longitude of Natches W from Salem	1	22	0	3
. . . . or W from Greenwich	6	5	32	3

The observatory of Mr. Dunbar is 9″ east from the Castle of Natches. Hence the longitude of that Castle is 6 5 41 3

I have not yet been able to obtain any European observations of the Eclipse, to compare with those made in this country.